N.L./TARACORP SUPERFUND SITE LEAD CLEAN-UP

A JUSTIFIABLE APPROACH

Presented at the 25th Annual
Conference on Trace Substances in
Environmental Health

University of Missouri
Columbia, Missouri

May 20-23, 1991

By: Brett L. Hanke & Craig Tarpoff

I N D E X

		PAGE
I.	PREFACE	i
II.	SITE HISTORY	1
III.	REMEDIAL ACTION PLAN	11
IV.	EPA EVALUATION CRITERIA	14
V.	THE DILEMMA	26
VI.	EPA'S DECISION PROCEDURE	28
VII.	THE CONSEQUENCES	32

II. SITE HISTORY[1]

SECTION 1 - INTRODUCTION

1.01 Site Background Information

The Granite City Site (Site) is the location of a former secondary lead smelting facility. As shown in Figure 1, the Site is located in Madison County, Illinois, at 16th Street and Cleveland Boulevard in Granite City. The area surrounding the site is primarily utilized by heavy industry. The Site is presently owned by Taracorp, Inc. (Taracorp) and is contiguous to properties owned by Trust 454, Terminal Railroad Associates, Inc., Illinois Central Gulf Railroad, Chicago and Northwestern Railroad, and Tri-Cities Trucking Inc. (TCT). St. Louis Lead Recyclers, Inc. is a tenant of Trust 454. Figure 2 presents these and other properties proximate to the Site.

Metal refining, fabricating, and associated activities have been conducted at the Site since before the turn of the century. Prior to 1903, the facilities at the Site included a shot tower, machine shop, factory for the manufacture of blackbird targets, sealing wax, manufacture of mixed metals, refining of drosses, and the rolling of sheet lead. Since 1903 facilities have been added to provide secondary smelting capabilities. Battery recycling facilities were installed in the 1950's.

A site map showing the facilities is presented as Figure 3. The secondary smelting operations produced a number of products, including sheet lead, solder, shotgun lead pellets, lead wool, lead pipe, powdered lead, and secondary lead ingots.

[1]Remedial Investigation Granite City Site, Sept., 1988 by O'Brien & Gere Engineers Inc.

I. PREFACE

The City of Granite City, Illinois, is the location of the N.L. (National Lead)/TARACORP Superfund Site. Lead processing operations were active from the turn of the century until the early 1980s. These operations have contaminated the area surrounding the site to a radius of approximately one mile.

In 1990, the EPA finalized its "Record of Decision" (ROD), outlining the remedial actions which must be implemented by the industrial responsible parties. There is perceived to be significant problems with the ROD in that what it mandates to be done has not been justified.

The purpose of this paper is to solicit the assistance of the scientific community in getting EPA to rescind its ROD and develop a remediation plan which is scientifically justifiable. The secondary purpose is to educate the scientific community on how their research is being misinterpreted and caution them to present findings in a definitive manner.

Figure 4 presents a process flow diagram for the facilities existing prior to February 1983. The major pieces of equipment involved in the secondary smelting activities included a blast furnace, a rotary furnace, several lead melting kettles, a battery breaking operation, a natural gas-fired boiler, several baghouses, cyclones and an afterburner.

Historically, solid wastes generated by the manufacturing facilities were stored on-site in a slag storage area as shown in Figure 3. There are also reports that hard rubber from reclaimed battery cases were removed from the Site by area citizens and governmental authorities (Venice Township) for use as fill and alley paving material. Liquid wastes from the manufacturing operations are discharged via process sewers to the municipal sewer system. Granite City utilizes combined sewers running under the Site to transport wastewater to treatment facilities.

The Site was owned by the Hoyt Metal Company until 1903, when the United Lead Company purchased the property. NL Industries, Inc. (NL), formerly the National Lead Company, bought the Site in 1928. In August, 1979 NL sold the Site to Taracorp. Taracorp operated the secondary smelting operation until 1983, when it filed for protection from its creditors under Chapter 11 of the Federal Bankruptcy Code. Taracorp continues to operate the metal refining and fabricating facilities at the Site.

In June of 1981, SLLR began reclaiming operations with the waste pile on the Taracorp property. The day to day activities continued through June 1983. It has been estimated that, during this time period, 11,000 tons of the waste pile material were processed by SLLR. The reclaiming operations resulted in several small piles of non-recyclable materials (i.e., slag and hard rubber battery case material) to the southwest of Taracorp's waste pile. Analytical results of samples obtained from the SLLR piles indicate that the materials in these piles are similar to those in the Taracorp waste pile, in that they contain elevated concentrations of lead and other heavy metals.

State and Federal regulatory agencies have had a series of contacts with the facility since the 1970's. Appendix A of RI/FS (omitted) presents a summary of the regulatory response actions that were documented in files maintained by NL.

The Illinois Environmental Protection Agency (IEPA), pursuant to requirements of the Clean Air Act, completed the Illinois State Implementation Plan Volume 9 for lead in February, 1981. The area which included the Site was designated as a nonattainment area with respect to the National Ambient Air Quality Standard (NAAQS) for lead of 1.5 ug/m3. In response to elevated ambient air lead concentrations and the findings of the 1981 Report, the IEPA conducted a study on lead pollution in Granite City and two nearby areas, Madison and Venice. This study, published in April 1983, was concerned not only with ambient air lead concentrations, but also with lead concentrations in soil, garden vegetables and water. In addition, blood lead concentrations of residents living in the vicinity of the Site were evaluated, and a risk assessment was conducted. The findings of the study indicated that, although a major near term risk to public health did not likely exist, elevated soil lead concentrations observed near the Site were cause for concern (IEPA, 1983).

A State Implementation Plan - Granite City was published in September 1983 by the IEPA. The IEPA's 1983 Report indicated that the lead nonattainment problem was in large part attributable to emissions associated with operation of the secondary lead smelter and lead reclamation activities conducted by SLLR. The IEPA therefore procured Administrative Orders by Consent with Taracorp, St. Louis Lead Recyclers, Inc., Stackorp, Inc., Tri-City Truck Plaza, Inc. and Trust 454 during March 1984. The orders specified the implementation of remedial activities relative to the air quality.

The U.S. Environmental Protection Agency (USEPA) determined that the Site was a CERCLA facility. Due to Taracorp's bankruptcy and NL's former ownership of the Site, NL voluntarily entered into an Agreement and Administrative Order by Consent (Consent Order) with the USEPA and IEPA in May 1985 to implement a Remedial Investigation and Feasibility Study (RI/FS) of the Site and other potentially affected areas. NL retained O'Brien & Gere Engineers, Inc. (O'Brien & Gere) in July 1985 to conduct the RI/FS in accordance with the Consent Order. O'Brien & Gere prepared a Work Plan which was approved by the Illinois EPA and USEPA (O'Brien & Gere, 1986).

1.02 Nature and Extent of Problem

The nature of the problem on and near the Site is one of lead and other heavy metals in several environmental matrices.

Lead concentrations have been observed in surface soils at on-site and off-site locations (IEPA, 1983). The off-site locations at which lead concentrations have been observed include properties surrounding the Site, and properties in Venice Township, south of the Site, where hard rubber from battery cases was utilized and fill material and/or paving material by private parties and Venice Township.

The waste pile on the Site contains slag, lead bearing fines in 55-gallon drums, and plastic and hard rubber from battery cases. Samples of these material exhibit elevated lead concentrations as well as other heavy metals associated with the secondary lead smelting industry.

Adjacent property owned by TCT was sampled during the IEPA 1983 study. The results indicated elevated lead concentrations. SLLR property has also been tested with a similar determination.

1.03 Remedial Investigation Summary

The objectives of the RI were to:

1) identify environmental conditions on and off the site relative to facility operations;
2) address potential health and environmental impacts resulting from the existing environmental conditions; and
3) develop a set of preliminary remedial technologies to be evaluated during the Feasibility Study.

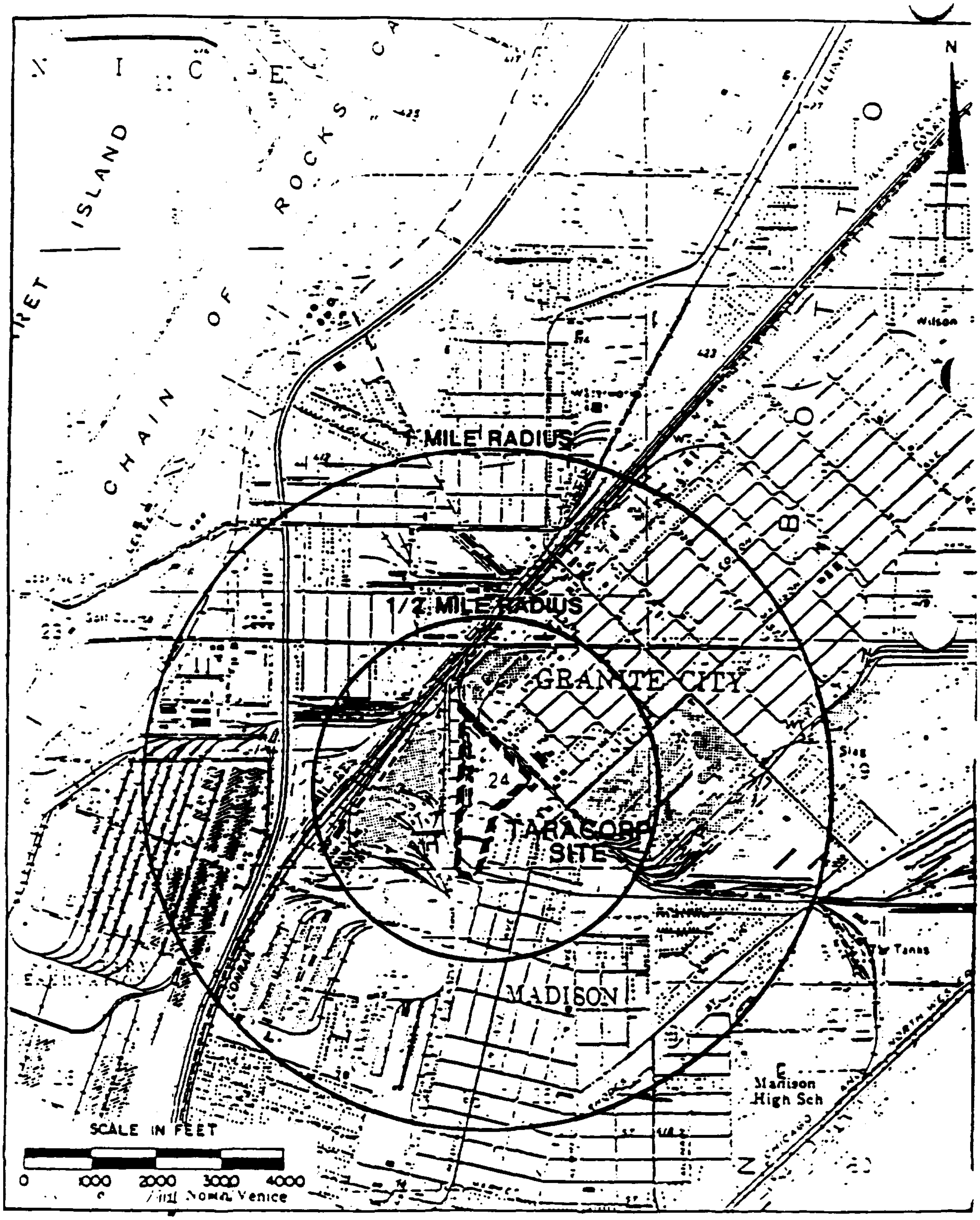
To accomplish these objectives, samples of on-site and off-site surface soils, waste materials from the slag piles and SLLR pile, surface water, and ground water were obtained and analyzed for heavy metals and other inorganic parameters. The analytical results were used to determine potential health and environmental impacts associated with the observed environmental conditions and to identify preliminary remedial technologies.

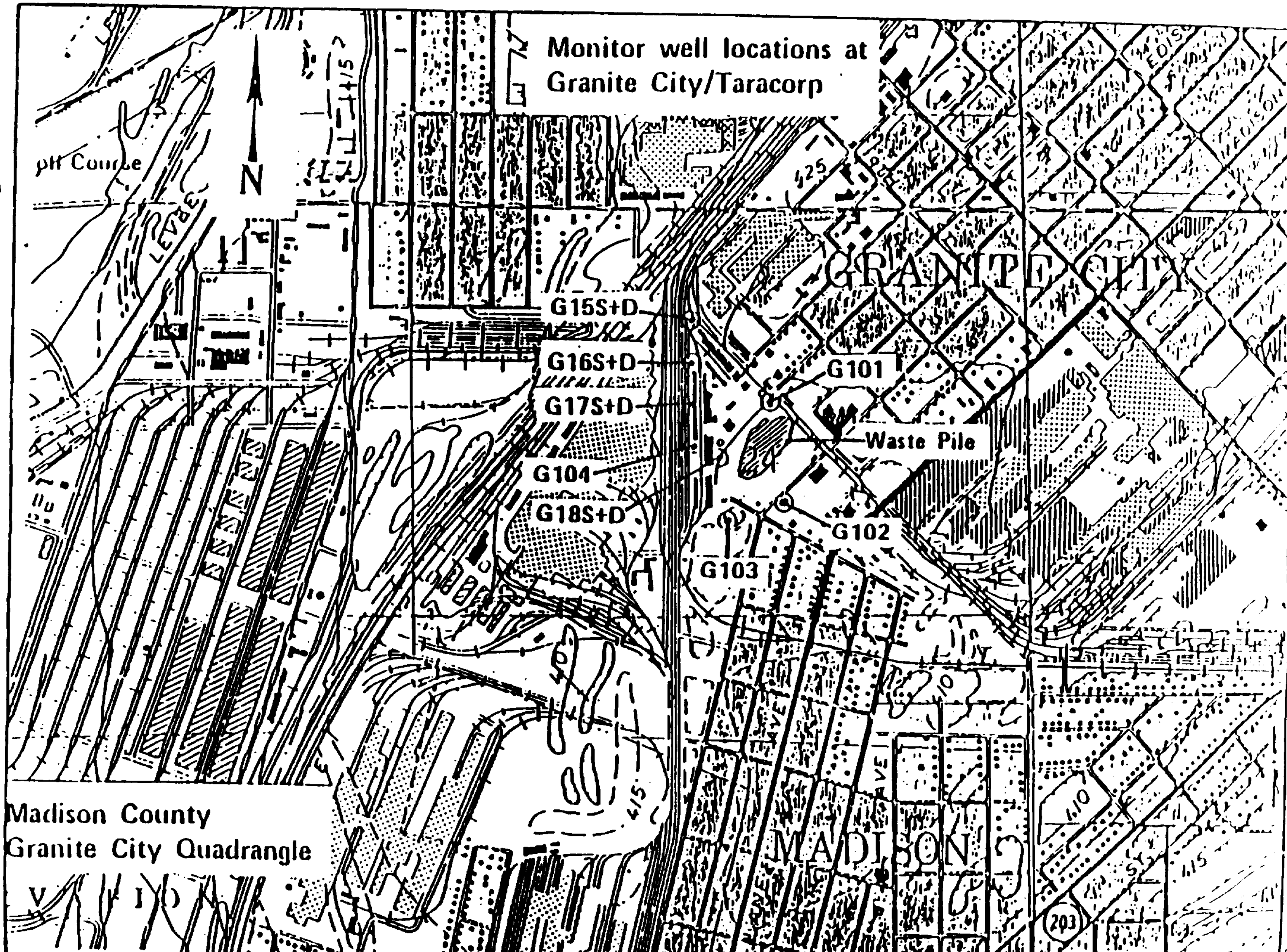
The field activities included sampling ground water and measuring ground water elevations during each of the seasons of 1987. Two additional wells were installed to clarify ground water flow directions. Eight soil borings in the vicinity of the slag pile were conducted to clarify the extent and nature of an underlying clay material. In addition, two test pits were excavated in the slag pile to provide information on the stratigraphy within the pile.

The analytical program included analysis for many metals as well as selected anions and indicator parameters. A detailed evaluation of the data generated concluded that the data were useable for the purposes of the Remedial Investigation/ Feasibility Study.

FIGURE 1

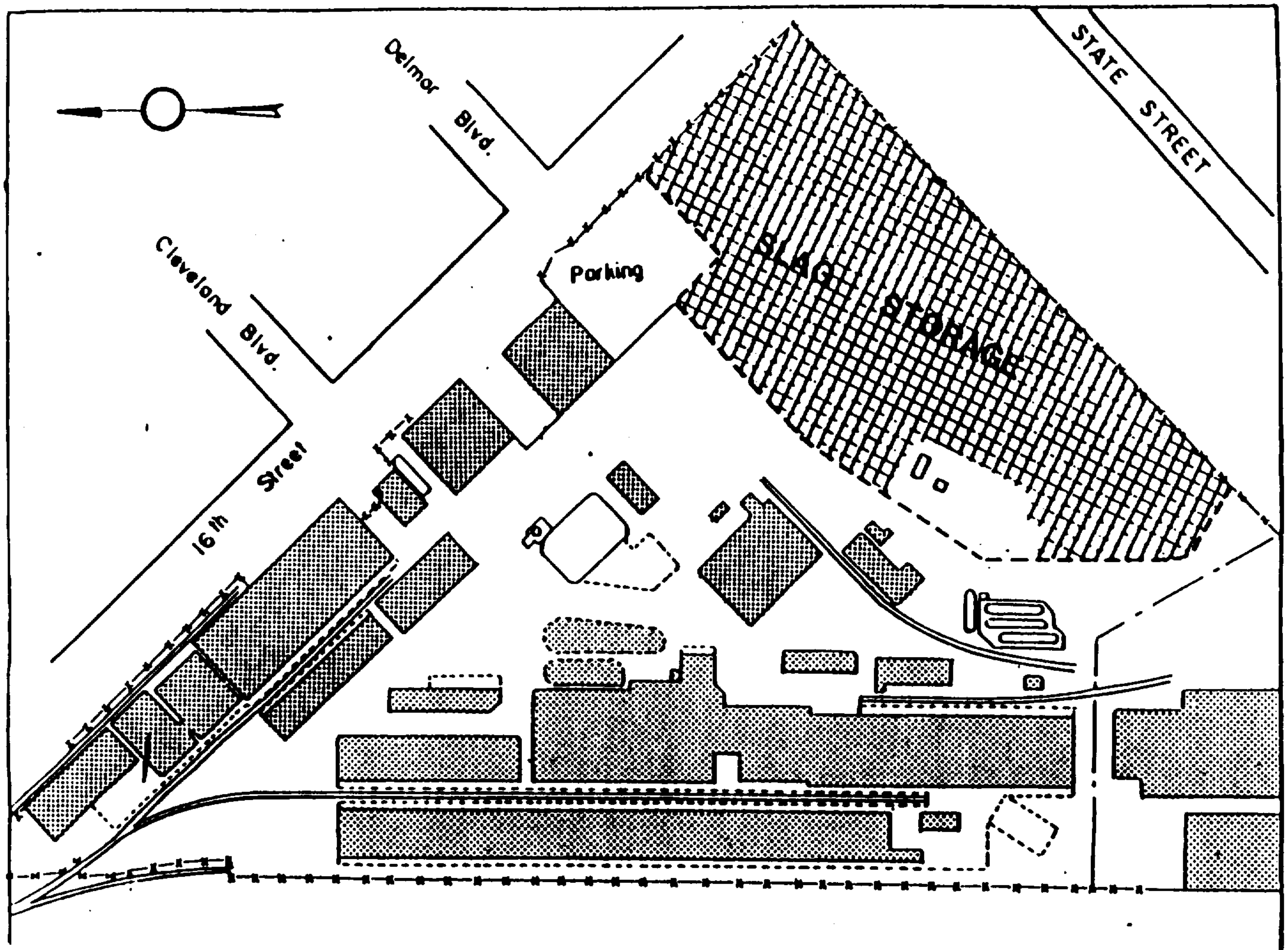
LOCATION MAP





Monitor well locations at Granite City/Taracorp

FIGURE 2



TARACORP SITE PLAN

Scale

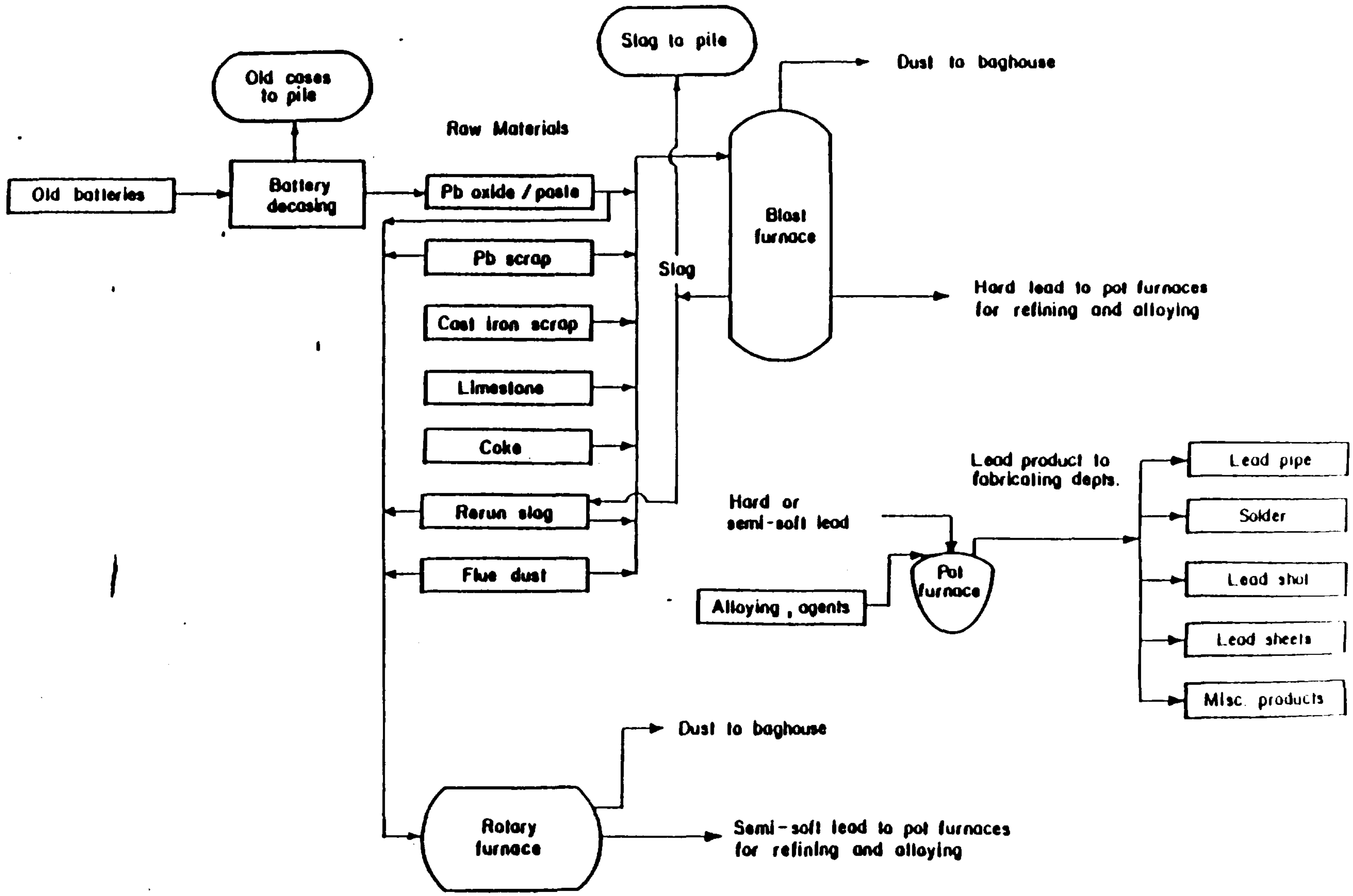
1" = 160'

160 80 0 80 160

FEET

FIGURE 3

PROCESS FLOW DIAGRAM FOR TARACORP SECONDARY LEAD SMELTER



III. REMEDIAL ACTION PLAN[1]

The major components of the selected remedy include:

- Installation of an upgraded security fence around the expanded Taracorp pile.
- Deed Restrictions and other institutional controls to ensure protection of the Taracorp pile.
- Performance of soil lead sampling to determine which areas must be excavated and the extend of the excavation.
- Inspection of alleys and driveways and areas containing surficial battery case material in Venice, Eagle Park Acres, Granite City, Madison and any other nearby communities to determine whether additional areas not identified in the Feasibility Study must be remediated as described below.
- Performance of blood lead sampling to provide the community with current data on potential acute health effects associated with site contamination.
- Installation of a minimum of one upgradient and three downgradient deep wells, monitoring of groundwater and air, and inspection and maintenance of the cap.
- Removal and recovery of all drums on the Taracorp pile at a secondary lead smelter.

[1] Declaration for the Record of Decision, March 30, 1990, by USEPA Region V

- Consolidation of waste contained in an adjacent St. Louis Lead Recyclers piles with the Taracorp pile.

- Excavation and consolidation with the Taracorp pile or off-site disposal of battery case material from all applicable alleys and driveways in Venice, Illinois, Eagle Park Acres, and any other nearby communities.

- Excavation and consolidation with the Taracorp pile of all unpaved portions of adjacent area with lead concentrations greater than 1000 ppm.

- Excavation and consolidation with Taracorp pile or off-site disposal of all residential soils and battery case materials around the site and in Venice, Eagle Park Acres, and any other nearby communities with lead concentrations greater than 500 ppm.

- Inspection of the interiors of homes on property to be excavated to identify possible additional sources of lead

- Implementation of dust control measures during all remedial construction activities.

- Construction of a RCRA-compliant, multi-media cap over the expanded Taracorp pile and a clay liner under all newly-created portions of the expanded Taracorp pile.

- Development of contingency plans to provide remedial action in the event that the concentration of contaminants in groundwater or lead or PM_{10} (particulate matter greater than 10 microns) in air exceed applicable standards or established action levels, or that waste materials or soils have become releasable to the air in the future.

° Development of contingency measures to provide for sampling and removal of any soils within the zone of contamination described by the soil lead sampling to be implemented above with lead concentrations above 500 ppm which are presently capped by asphalt or other barriers but become exposed in the future due to land use changes or deterioration of the existing use.

IV EPA EVALUATION CRITERIA
(See Appendix A for Alternatives A - H)

EPA is required to identify alternative remediation plans for its superfund sites. These alternatives are then to be evaluated for nine criteria. They are:

1. overall protection of human health and the environment;
2. compliance with ARARs;
3. long-term effectiveness;
4. reduction of toxicity, mobility, or volume;
5. reduction of volume;
6. short-term effectiveness;
7. implementability;
8. cost; and
9. state and local acceptance.

The City takes issue with EPA's analysis of all of these criteria.

1. Overall Protection

EPA's ROD: "With the exception of the no action alternative, the treatment of Areas 4 through 8 in Alternative B, and the treatment of Areas 1 through 8 in Alternative D, all of the alternatives, as amended by the addendum to the Feasibility Study, would provide adequate protection of human health and the environment. Each of the alternatives found adequately protective of human health and the environment includes a residential soil lead clean-up standard of 500 ppm and a soil lead clean-up standard of 1000 ppm in Area 1. Levels of protectiveness are based on interim guidance and site specific analysis of Granite City and the surrounding communities (see Appendix B). The preferred alternative includes the elimination of direct contact with and inhalation of soils and waste materials contaminated with lead at concentrations above levels which may present a risk to public health by: removal of Taracorp drums and off-site recovery at a secondary lead smelter; excavation, restoration, and consolidation with the Taracorp pile of the SLLR piles, soils and battery case materials with lead concentrations greater than 500 ppm in residential areas in Areas 2 through 8, and battery case material in Venice Alleys and Eagle Park Acres; excavation, restoration, and consolidation of soils and waste materials in Area 1 with lead concentrations greater than 1000 ppm; and providing a multimedia cap over the Taracorp pile and providing institutional controls. The preferred alternative also includes installation of additional deep wells, air and groundwater monitoring plans, and contingency plans to be developed and implemented in the event that site-related contaminant levels in the air or groundwater exceed applicable standards or that materials in the expanded Taracorp pile become exposed or releasable to the air in the future."

Comments:

a. EPA alleges that a 500 ppm residential soil lead clean-up standard would provide adequate protection of human health. This is not scientifically based. There has been no site specific testing or blood sampling to indicate that even a lower level might not be justified.

b. The ROD does not study, clean-up or otherwise address household dust, a potential major contributor to child lead ingestion.

c. The ROD requires groundwater monitoring and a contingency plan. This is insufficient. The groundwater testing necessary to develop a contingency plan should be conducted prior to issuance of a ROD. The provisions of the contingency plan should be prepared prior to issuance of a ROD to allow comment thereon.

2. **Compliance with ARAR's**

EPA's ROD: "Alternatives B through H would meet all Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State Environmental Laws except for State of Illinois General Use Water Quality Standards (35 IAC 302.208). These standards are applicable to groundwater beneath the site and are exceeded for sulfates, total dissolved solids, iron, manganese and zinc. The standards for these perimeters were developed to ensure the aesthetic quality of water and concentrations in excess of the General Use Standards for these perimeters would not present a health concern. Cadmium was also present above the General Use Standard during three rounds of sampling but not during the most recent sampling. The groundwater monitoring and additional deep well installation included in all alternatives will verify cadmium concentrations and monitor concentrations of all other perimeters of concern. Care would have to be exercised with Alternatives E, F and G to ensure that Taracorp pile excavation activities do not create exceedances of air ARARs.

Additionally, the consolidation of excavated contaminated soils from the residential areas around the site is included in Alternatives D and H due to the fact that these areas are within a zone of continuous contamination created by the airbone deposition of lead from the smelter stack thoughout its years of operation. Lead contamination is highest next to the smelter stack (on-site) and gradually decreases with increasing radial distance from the stack, and the nearest residential areas to be excavated are physically separated from the site boundary by one roadway, 16th Avenue."

Comments:

A complaint has been filed with the City that the addition of material to the pile constitutes a violation of a City ordinance prohibiting dumps in the City.

3. **Long Term Effectiveness:**

EPA's ROD: "Alternatives E, F and G would provide good long-term effectiveness against direct contact with and inhalation of soils and waste materials containing lead concentrations above levels which may present a risk to public health, as well as an additional barrier against leaching of lead and other metals into the groundwater. The preferred alternative (i.e., Alternative H) would provide similar long-term effectiveness but would not provide the additional barrier (bottom clay liner) against leaching metals under the present Taracorp pile; however, the groundwater does not represent a complete risk pathway at this site. With the exception of Areas

4 through 8, for which no remediation is provided, Alternative B would eliminate the risk of human exposure in off-site areas upon completion of remediation but would not provide long-term effectiveness in these areas due to maintenance requirements and the potential for uncontrolled excavation. With the exception of Areas 4 though 8, for which no remediation is provided, Alternative D would provide good long-term effectiveness with respect to materials consolidated with the Taracorp pile; however, at Areas 1, 2, and 3, lead concentrations at 3 inches beneath the ground surface would remain at levels which may present a risk to public health. The no action alternative allows waste materials to remain in place and, thus, has poor long-term effectiveness."

Comments:

a. The ROD provides for consolidation of contaminated piles and residential soil with the Taracorp pile and capping it. It would be left in the center of the City. The recycling alternative is rejected as infeasable because the materials are not recyclable, although similar materials are being recycled at a Portland, Oregon site. Removal of the pile is rejected as infeasable due to dust created during material handling. However, EPA anticipates no dust problem with consolidating the piles. The only long term effective solution is recycling. This should be studied as it was at the Portland site.

b. According to the BOCA Code, Granite City is in a Sizmic Zone II. This means that it is prone to earthquake activity. Situated on 90 feet of sand and gravel in the Mississippi flood plain, leaving a pile of contaminated waste seems less than prudent as a long term solution. When sandy soils, especially those saturated by a high water table like exists in Granite City, are vibrated, they liquify and shift. This would cause that contaminated pile to settle into the groundwater causing a serious condition. How much better it would be to recycle and relocate the contamination.

4. & 5. Reduction of Toxicity, Mobility, or Volume

EPA's ROD: "With the exception of the no action alternative, all alternatives provide a reduction of mobility of contaminants; the degree of mobility reduction provided, from least to greatest, is Alternative B, D, H, E, F, then G. The no action alternative does not provide any reduction of toxicity or volume, Alternatives B, D, H, and E provide a slight reduction of toxicity and volume by removal and recovery of Taracorp drums, and Alternatives F and G provide a slightly greater reduction of toxicity and volume by recycling some waste materials. The reduction of volume effected by Alternatives F and G has been calculated to be less than 10%, based on the quantity, nature and physical condition of recyclable materials in the Taracorp pile. A recycling effort on the Taracorp pile was conducted in the early 1980's by St. Louis Lead Recyclers. The effort was unsuccessful in that anticipated volume reductions were not achieved and the material remaining after recycling was more contaminated than that which entered the process. The nature of the materials in the Taracorp pile is not conducive to a successful recycling effort and will potentially create a greater adverse health impact to workers and the public than would exist if the materials remain in place. Treatment/stabilization has been applied to contaminated soils at other sites, but has not been successfully applied to waste materials such as exist in the Taracorp pile. Additionally, Alternatives F and G would produce a contaminated sludge as a result of precipitation of rinse waters used for recycling."

Comments:

a. Again, there has been a pilot study performed on a similar pile at the Gould Superfund Site in Portland, Oregon. That study determined that recycling of a pile of this type of material is feasable. A pilot study should be performed on the Taracorp pile to determine if a significant reduction in toxicity, mobility and volume can be achieved feasably.

b. Section III of this report documents the Remedial Action Plan from the ROD. The term "nearby communities" is repeatedly used in discussions of what measures are to be implemented. The City is very concerned about becoming a depository for contamination from "other communites". How much material from how far away are key questions left unanswered by the ROD. Adding to the Taracorp pile does not reduce volume in Granite City.

6. **Short Term Effectiveness.**

EPA's ROD: "Implementation of Alternatives A and B would produce minimal short-term impacts to the community, workers, or the environment, as contaminated material would be left in place. Implementation of Alternatives D, E, F, G, and H could generate dust in residential and commercial areas, which would require monitoring and control. Alternative D would be of shorter duration and would involve the movement of less materials than Alternative H, which would in turn involve less materials movement than Alternatives E, F, and G. Alternatives E, F, and G include significant excavation at the Taracorp pile; the generated dust could impact the community, workers, and the environment. Control measures would be required. Alternatives F and G also include extensive manual handling of waste materials at the Taracorp pile; worker health and safety could be jeopardized through ingestion of and direct contact with lead containing materials.

The following periods of time are required to implement the remedial construction activities for each alternative:

Alternative	Time
A	6-12 months
B, D	1-2 Years
H	Approximately 2½ Years
E	3½ - 4½ Years
F, G	5½ - 6½ Years"

Comments:

a. The discussion of dust is contradictory. Either dust will be caused and will be a problem, or it won't. If control measures can be implemented for consolidating the piles and excavating residential areas, then they will work for removal or recycling of the Taracorp pile.

b. A more salient issue, which is not even addressed by EPA, is not how long construction takes or dust control, but whether the remedial measures are needed at all. There is no imminent health hazard; therefore, studies can be performed to determine the feasibility of pile recycling and what residential area clean-up measures are needed.

7. **Implementability**

EPA's ROD: "Alternatives A, B, D and H would utilize standard monitoring and construction techniques which would be readily implementable. The excavation of the Taracorp pile and other soils and waste materials incorporated in Alternatives D, E, F, G, and H would require dust control measures. The segregation and recovery utilized by Alternatives F and G, however, would utilize equipment designed to handle batteries, not the slag and waste materials present at the Taracorp pile. In addition, the recovered products may not be suitable for recycling: the recovered plastic may not pass the TCLP test for lead, and the lead content of the recovered slag/dirt/lead mixture may not be high enough to be acceptable to a secondary smelter."

Comments: Note that the ambiguous word "may" has been used by EPA three times in the ROD paragraph on implementability. In fact, the EPA does not know if their alternatives are or are not implementable. A pilot study is necessary.

8. Cost

EPA's ROD: "Cost - The costs of each alternative are presented below. It must be noted that these are estimated costs. More detailed cost estimates will be prepared during the Remedial Design phase of the project.

Alternative	Capital Cost	O & M	Present Worth
A	$143,840	$21,550	$475,110
B	$5,142,390	$35,300	$5,685,020
D	$6,292,820	$35,300	$6,835,450
E	$30,500,000	$35,300	$31,000,000
F	$44,500,000	$35,300	$45,000,000
G	$66,500,000	$5,300	$67,000,000
H	$24,500,000	$35,300	$25,000,000"

Comments:

a. **EPA has revised the cost estimates several times. This is just an estimate; however, the ROD plan estimate appears quite low. At the Bunker Hill Superfund site in Kellogg, Idaho, lots similar to those in Granite City, about 50' by 100' cost about $20,000 per residence to excavate 12" deep. In Granite City there are about 600 lots in the 500 to 1000 ppm clean-up area. This alone equates to $12 million, not considering excavation of areas in excess of 1000 ppm, pile consolidation, capping, and other measures.**

b. **It seems unjustifiable to spend any amount of money on a plan which is not based on scientific data. The cost of acquiring data is minimal. The estimated cost of performing a health effects study in the Granite City area is $300,000. The cost of the pilot study for recycling the battery casings pile in Portland was $ 25,000.**

9. State and Local Acceptance

EPA's ROD:

"State Acceptance - The State of Illinois supports the preferred alternative.

Community Acceptance - Community acceptance of the preferred alternative has been evaluated and it has been determined that the following five elements should be added to the preferred alternative: 1) blood lead sampling in the surrounding community, 2) home interior inspections on properties to be excavated, 3) provisions to remediate additional areas in Eagle Park Acres, Venice, Granite City, Madison, and other nearby communities where battery case materials are located at or near the surface and which were not identified in the draft FS Report, 4) construction of a clay liner under the newly-created portions of the expanded Taracorp pile and 5) establishment on contingency measures to provide for proper disposal of contaminated soil due to land use changes within the zone of contamination. The Responsiveness Summary is included in Appendix A of this Record of Decision and addresses all comments received during the 60 day public comment period."

Comments:

a. It is not known which agency of "the State of Illinois supports the preferred alternative". However, the Illinois Department of Public Health, Division of Environmental Health has repeatedly spoken in oposition to implementing the plan without performing field studies to determine appropriate remedial measures. This opposition is a matter of record in the transcript of the public hearing held by EPA to solicit local comments. It is also documented in several news articles.

b. The local community's reaction could best be summarized as outrage. A petition with over 600 signatures in opposition to the "preferred alternative" was submitted during the public comment period. The public comment hearing has been characterized as a two hour EPA sales pitch for the "preferred alternative". The City administration has repeatedly met with EPA to try to get a commitment from EPA to conduct an appropriate health study and pilot investigation, and base any clean-up plan on it. The added five elements fall well short of an appropriate health study and EPA had steadfastly maintained that no change in the "preferred alternative" plan will be made based on the results thereof. It is as much Region 5, USEPA's ominipotently arrogant demeanor as it is its steadfast refusal to base the remediation on science which has aroused the public ire.

V THE DILEMMA

The City believes that Region V, USEP's failure to apply sound scientific principles has jaundiced their evaluation of alternatives against all but the second criteria above.

In the ROD, EPA alleges "the nature of the materials in the Taracorp pile is not conducive to a successful recycling effort". However, a similar pile was evaluated in a pilot study at the Gould Superfund Site in Portland, Oregon, and recycling was included in the ROD. It appears that EPA's rejection of this alternative is not based on any scientific data. No pilot study was performed.

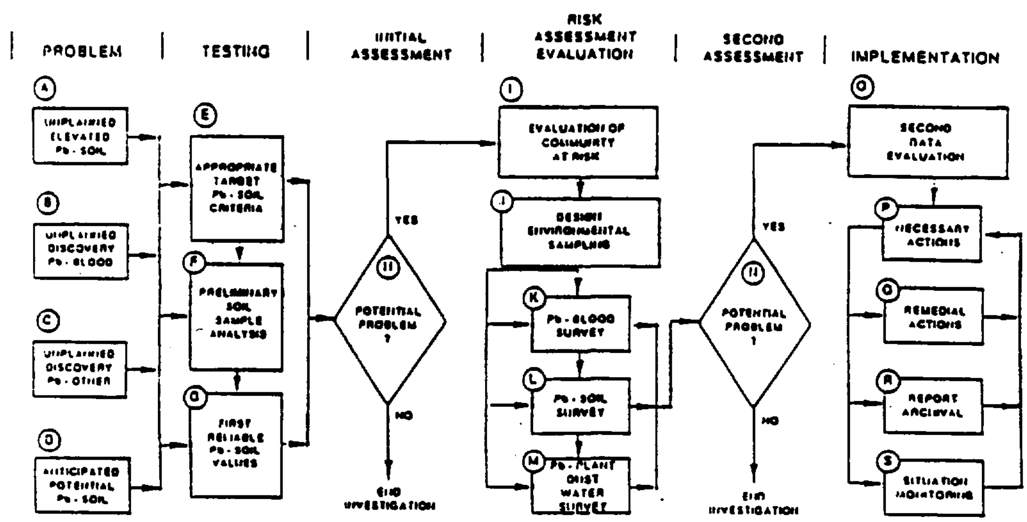
The EPA openly admits that the soil lead clean-up level, the most expensive component of the remedial plan, was selected without scientific basis. Appendix B of the ROD sets out the logic. It states that because the National Centers for Disease Control is <u>considering</u> lowering its recommended acceptable blood lead level from 25 ppb to 15 ppb, EPA is rejecting the Risk Assessment contention that 15 ppb can be considered a threshold level for adverse health effects. Further, EPA has withdrawn its Reference Dose (RFD) for lead which has caused them to issue OSWER Directive #9355, 4-02, 1989. This directive sets forth an interim soil clean-up guideline for total lead in soil at 500 to 1000 ppm. Again, a subjectively selected criteria <u>range</u>. The Risk Assessment established a clean-up level of 1000 ppm, EPA chose 500 ppm, all done subjectively and in contrast to guidance from EPA's own Environmental Criteria and Assessment Office which suggested the use of an uptake/biokinetic modeling approach.

EPA claims in their ROD that "When site-specific data collected in Granite City and soil lead/dust lead levels of 500 ppm and 1000 ppm were input into the Lead Uptake/Biokinetic Model, the graphs presented in Figures 1 and 2 were obtained". They then use the graphs derived to justify a 500 ppm soil clean-up level. The quote is not a true statement. The only "site specific" number used was that for lead in the air. Thus, their use of the biokinetic uptake model has no scientific basis.

The City simply wants research done before a remedial plan is developed on which such a plan can be scientifically justified. Before a huge wastepile is left in the middle of a City, a pilot recycling study should be performed. Before a soil lead clean-up level is established, site specific data should be developed and input into the biokinetic uptake model. EPA has stated that there is no imminent health hazard, so there appears to be no reason to implement an unjustified plan.

VI EPA'S DECISION PROCEDURE

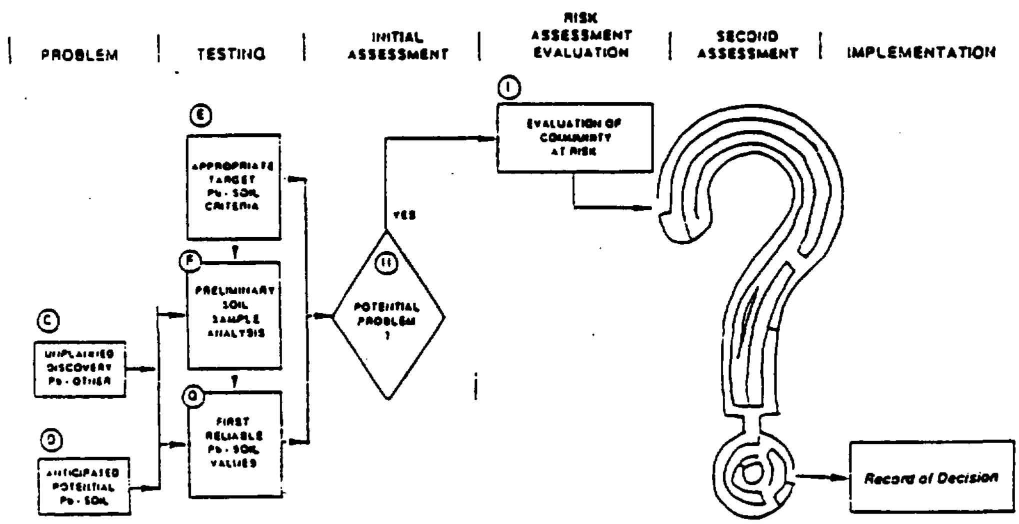
It is not known exactly what EPA's decision making protocol is. However, the Society for Environmental Geochemistry and Health (SEGH), Special Task Force spent three years preparing such a protocol which was presented at the 25th Annual Conference on Trace Substances in Environmental Health, May 20-23, 1991. This protocol is summarized in the following flow chart extracted therefrom.



PHASED ACTION PLAN FOR LEAD IN SOIL

(From SEGH Lead In Soil Task Force)

As best as can be determined, the protocol used by Region 5, USEPA to determine the "preferred alternative", ROD plan shortcut several of the SEGH steps. This perceived protocol is summarized on the following flow chart.



The performance of a comprehensive health study has been proposed which would restore several of the missing steps in the EPA's protocol. Initially scheduled for the summer of 1990, per the ROD, the study was delayed until the summer of 1991. The scheduled date of the health study is at this time unknown. The study is summarized on the following page.

Summary of Summer 1991 Heavy Metals Study Activities in

Granite City, Illinois and Surrounding Areas

<u>Investigators</u>: Illinois Department of Public Health (IDPH) and their contractors. Grant administrators:

Thomas F. Long
Catherine Copley
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson
Springfield, IL 62761
(217)782-5830

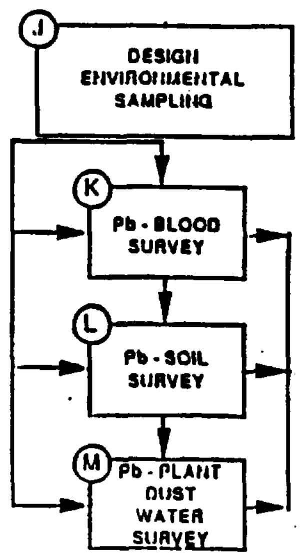
<u>Granting agency</u>: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry

<u>Title of protocol</u>: Multistate Heavy Metals Exposure Study in Illinois, Kansas, and Missouri

<u>Individuals responsible for research protocol</u>: Fred Stallings (M/S 31) and Sara Sarasuwa, Agency for Toxic Substances and Disease Registry, Executive Park, Atlanta, GA 30333, (404) 639-0563

<u>Purpose</u>: Determination of blood and urine levels of heavy metals in sensitive populations in study area to compare to levels found in control populations as well as to health guidelines; determine any correlation of heavy metal levels between blood levels and environmental levels (soil, dust, paint, water); determine hierarchy of risk factors; and to determine if biomarkers can be can be identified that may indicate heavy metal exposure.

<u>Study area</u>: Primarily area proposed for U.S. EPA remedial action for the National Lead/Taracorp National Priority List (NPL) site in Granite City, Illinois and an additional "buffer" zone to ensure complete coverage. This is estimated to be approximately 189 census blocks at this time.



VII THE CONSEQUENCES

There are numerous adverse consequences to implementing the "preferred alternative". It should be kept in mind that the City has no objection to such implementation, if it can be established that the "preferred alternative" is, in fact, the optimum approach based on scientific information. The adverse consequences relate to the areas of population inconvenience and economics.

Without a comprehensive health study, it cannot be established that soil removal from residential areas at the 500 ppm level is necessary or adequate. The USEPA spent millions of dollars in the nearby "Times Beach" site on an unjustified remediation plan because it was not adequately researched. The City would not like to see 600 families suffer the inconvenience associated with having their yards excavated and restored if it is not proven necessary. Further, the City would not like to have massive earthmoving operations undertaken in residential areas a second time because it was later determined that a 500 ppm clean-up level was inadequate.

Should a lesser soil excavation option be justified, a significant economic benefit stands to be derived not only by the responsible parties, but also by the City. The lessened cost of remediation is evident. Less evident is the effect on property values and the infrastructure. A considerable stigma which should have a significant adverse effect on property values will result from the publicity associated with a large clean-up. Further, the massive construction effort will cause damage to roads, curbs and sidewalks as equipment is operated. Soil will also be tracked onto streets which will enter the combined sewer systems effecting wastewater treatment.

The existance of a huge hazardous waste pile in the center of town is most undesirable. Its existance, especially if enlarged by huge amounts of residential soil, will create an adverse stigma as a landmark and affect property values. Should it be feasible to recycle a major portion of the pile, this stigma could be reduced or eliminated. It would also reduce the chance of future exposure and the potential need for future remediation measures. Recycling or removal of the pile would be costly, but it is believed that the benefits make it justifiable. This could be verified through a pilot/bench study.

APPENDIX A

DESCRIPTION OF ALTERNATIVES[1]

The alternatives that underwent detailed analysis are efly described below.

:ernative A - No Action

Monitoring:	Air Quality Monitoring; Ground Water Monitoring, Additional Deep Wells.
Institutional Controls:	Site Access Restrictions; Land Use Restrictions: Deed Restrictions; Sale Restrictions.

Estimated Total Remedial Costs: $475,110 Present Worth
Estimated Months to Implement: 6-12

:e no action alternative (A) includes a group of activities that .n be used to monitor contaminant transport. The sources onsidered potentially viable include air, surface soils, and :oundwater. It includes institutional controls on the Taracorp :operty and other properties where residual concentrations do ot meet Remedial Objectives. In addition, a minimum of one pgradient and three downgradient deep wells would be installed o monitor water quality in the lower portion of the aquifer; ell nests or clusters would be employed wherever possible.

lternative B

.aracorp Pile:	Multimedia Cap, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at Secondary Lead Smelter.
SLLR Piles:	Excavate and Consolidate with Taracorp pile.
Venice Alleys:	Asphalt or Sod Cover Based on Usage.
Eagle Park Acres:	Vegetated Clay Cap, Institutional Controls.
Area 1 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Area 2 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Area 3 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

[1]Declaration for the Record of Decision, March 1990 by Region V, USEPA

APPENDIX B

SELECTION OF A LEAD SOIL CLEAN-UP LEVEL FOR THE NL/TARACORP SUPERFUND SITE

Prepared by U.S. EPA, Region V

Several sets of comments to the Proposed Plan at the NL/Taracorp site have questioned U.S. EPA's decision regarding the selection of the lead in soil clean-up standards to be used at the site. This document is intended to respond to these comments by setting forth U.S. EPA rationale supporting this decision.

Lead poisoning in young children is one of the most prevalent and preventable childhood public health problems in the U.S. today (USDHHS, 1985). The Environmental Protection Agency's concern with the health hazards of lead is longstanding - The Clean Air Act of 1970 authorized the EPA to set National Ambient Air Quality Standards (NAAQS) for the regulation of air emissions of pollutants considered harmful to public health or welfare; lead was one of the six pollutants to be regulated. In 1974 under the regulatory requirements of the Safe Drinking Water Act, EPA Office of Drinking Water issued its National Interim Primary Drinking Water Regulations; again lead was one of the 26 contaminants addressed. Since 1975, EPA has increasingly restricted automobile emissions; all new cars since 1975 have been equipped with catalytic converters. Because lead destroys the effectiveness of these converters, the use of unleaded gasoline has increased dramatically, with corresponding decreases in lead emissions from exhaust. EPA has moved to accelerate this progress by phasing out lead in gasoline during the 1980s.

Further reductions in the National Ambient Air Quality Standard for lead and the Maximun Concentration Level for lead in drinking water are expected in 1990. The overall effect of these control programs has been a major reduction in the amount of lead being released to the environment.

Lead released into the environment in the past from stationary sources such as factories, power plants and smelters and from mobile sources such as automobiles, buses and other forms of transportation remains a persistent problem. Deposition and precipitation have resulted in the accumulation of high concentrations of lead in the soil in areas where significant releases to the air have occurred. Thus, lead-contaminated soils and housedust have emerged as important contributors to blood lead concentrations in the general population.

The present action has provided a mechanism for the clean-up of the lead in the soil at the NL/Taracorp Superfund site in Granite City. A risk assessment has been prepared by O'Brien & Gere as part of the Remedial Investigation for the NL/Taracorp Superfund site (Remedial Investigation Report 1988). This health risk assessment has correctly identified children as the most sensitive subpopulation, noting that they are at particular risk to lead poisoning due to their greater lead absorption efficiency than adults and to their greater probability of exposure to environmental lead in soil through outdoor play activities, mouthing habits and through intentional ingestion of soil (pica). It further identifies two pathways for lead exposure to the resident population stemming from the Superfund site as being complete: " 1) the airborne route, with lead-bearing soil particulates and dusts transported from friable soils on the Taracorp site to offsite locations for subsequent inhalation, and 2) the direct contact route, with exposed soils previously contaminated with lead from particulate fallout from smelting emissions in previous years providing a source for ingestion of lead residues". Pathways have been identified as complete based on contaminant existence, magnitude, environmental fate, toxicological impacts of components released from the site and transport to receptors. The assessment also acknowledges that "lead in its various environmental forms is able to combine with a variety of physiologically significant proteins in the body, with resultant effects on structure and function".

Because children are developing, they absorb and retain more lead than adults. Thus, even at very low levels of lead exposure, children can experience reduced I.Q. levels, impaired learning and language skills, loss of hearing, and reduced attention spans and poor classroom performance. At higher levels, lead can damage their brains and central nervous systems, interferring with both learning and physical growth. Needleman (1988) has provided a review of 110 publications documenting the health effects of lead in children. He summarized that at low blood lead levels, neurocognitive effects of lead expressed as diminished psychometric intelligence, attention deficits, conduct problems, alterations in the electroencephalogram, school failure and increased referral rates for special needs predominant. He emphasizes that careful epidemiologic studies, which have controlled for the important confounders, have set the level for these effects at 10-15 micrograms per deciliter lead in blood. Exposure to lead in men can cause increases in blood pressure. These health effects and their associated blood lead levels have been summarized by EPA and the Agency for Toxic Substances and Disease Registry (ATSDR), and are summarized in Table 1. Particularly notable are the risks of lead to women of child-bearing age. They include fertility problems and miscarriages. In pregnant women, lead can cause impaired development of the fetus, premature births and reduced birth weights. The data in Table 2 shows that miscarriages and reproductive effects, such as premature birth and low birth weight, may occur at blood lead levels as low as 10 micrograms per deciliters and possibly lower. It is this growing preponderance of literature that has prompted the National Centers for Disease Control (CDC) to consider the lowering of the blood lead level from 25 to 15 micrograms per deciliter to protect for the health effects seen at lower levels. It is also this same growing accumulation of evidence that has led EPA to reject the suggestion put forth by the contractors for NL Industries in their risk assessment that the proposed 15 micrograms per deciliter blood lead level can be considered as a threshold level for the adverse health effects of lead in children. This lack of ability to identify a thresold level for lead coupled with the understanding that Reference Dose (RfD) methodologies are basically route-specific and do not incorporate site-specific information has led EPA to withdraw the RfD for lead. The EPA Environmental Criteria and Assessment Office (ECAO) has suggested instead the use of an uptake/biokinetic modeling approach to develop health critera for lead (U.S.EPA 1989b).

Many considerations have gone into the documentation of a lead soil clean-up level for the NL/Taracorp Superfund site. The first was the inability to find a suitable basis on which to perform a risk assessment based on dose-response relationships given the withdrawal of the RfD for lead. The second was the EPA Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive # 9355.4-02, 1989). This directive sets forth an interim soil clean-up guideline for total lead in soil at 500 to

1,000 ppm. However, it also allows that "site-specific conditions may warrant the use of soil clean-up levels below 500 ppm or somewhat above the 1000 ppm level". This latter guidance was used to evaluate the conditions at the NL/Taracorp Superfund site.

A number of factors have influenced the setting of a lead soil clean-up level for the NL/Taracorp site.

1) The soil at the NL/Taracorp (Granite City) site has been documented as containing elevated levels of lead (Remedial Investigation Report 1988).

2) Smelter operations are known to result in the emission of small aerosol particles which stay airborne and travel over an extensive area (Steele 1989). Because the lead deposits at the NL site originated from air emissions from smeltring operations, the resulting discharge was as fine particles having a wide area of distribution and deposition. (This area has not been fully delineated and further soil testing will be needed to determine the extent of the area contaminated by lead emissions from the NL Industries operations.)

3) The small particles deposited in the soil can cling to skin, clothing and children's toys and can be transferred into the indoor environment as windborne dust or carried in on the shoes or clothing of residents or the fur of household pets.

4) The small lead particles have high bioavailability, due to their easy dissolution in the stomach and the chemical form of the lead salts.

5) Even low exposures to lead have been shown to have significant health effects on developing children, especially those under the age of six years.

6) Children who show tendencies toward frequent mouthing activities can ingest large amounts of soil and indoor dust and hence, large amounts of lead

(Calabrese 1989, Binder 1986). Those who are nutritionally compromised and/or exhibit pica might be at risk for severe health effects.

7) The area of Granite City most affected by the smelter emissions is highly residential and contains a significant number of young children - the subpopulation known to be the most sensitive to the toxic effects of lead.

8) Granite City and the surrounding area is highly industrialized and residents are likely to be exposed to a complex mixture of toxic substances in the air and in the soil, which may act to increase the toxic effects of lead in a synergistic manner. The assessment of health risks from chemical mixtures is of growing concern to EPA (FR 50 1985).

These factors indicate that there is a high possibility of adverse health effects in young children living in the Granite City areas impacted by the NL/Taracorp Superfund site. Accordingly, a soil lead clean-up level of 500 ppm was deemed necessary if this subpopulation is to be fully protected.

This lead soil clean-up level is consistent with the approach being taken for similiar contaminated sites in other countries, other Regions in the U.S. and is advocated by researchers examining lead toxicity in pediatric populations. In a report to the Ontario Minister of the Environment by their Lead in Soil Committee, the committee responded to the request that they review the available literature on lead in soil and recommend "scientifically defensible" soil removal guidelines for lead-contaminated soil (OLSC Report 1987). The committee recommended that a 1000 ppm guideline level is appropriate for areas to which children do not have routine access, while a guideline level between 500 and 1000 ppm is appropriate for areas to which children do have routine access. The comments of the Royal Society of Canada were also included in the report. They recommended that for clean-up around lead-processing or lead-using plants, soil lead levels of up to 500 micrograms per deciliter are acceptable for residential areas and for garden and allotments, while levels of up to 1000 ppm should be acceptable for parklands and other areas to which children have only intermittent access. Similiar conclusions have been reached in the U.S. regarding the soil clean-up at lead smelter sites; lead soil clean-up levels in such impacted residential areas in Regions I, II and VIII have recently been set at 200 t 500 ppm. These are also the conclusions being echoed by researchers in the field. Milar and Mushak (1982) warned that a definite health hazard exists to children when household dust levels exceed either 1000 ppm or 50 micrograms per square meter. Mielke et al. (1989) summarized the work of a number of researchers addressing the question of the safe lead concentration in soil to protect children from undue exposure with the conclusion that a rapid rise in population blood lead levels takes place when the lead content of soil increases from less than 100 ppm to 500-600 ppm. Dr. Mielke has stated in a personal communication that he believes the safe lead soil level in areas contaminated with fine lead particles to be between 200 qnd 250 ppm. A study by Shellshear et al. (1975) in New Zealand concluded that children exposed to more than 100 ppm lead in soil and who also exhibit pica are at major risk to lead exposure.

The site-specific conditions presented earlier led Region V to consider the use of a modeling approach to further evaluate the lead soil clean-up level proposed for this site. This approach is consistent with the recent comments received from NL Industries that the incorporation of the Biokinetic Model and other generic and site-specific data into the development of clean-up levels for lead are appropriate (NL Industries comment to the public response, Exhibit A). The letter from Dr. Krablin, Manager for Environmental Projects, ARCO, included in Exhibit A defends the EPA Integrated Uptake/Biokinetic Model as having been "demonstrated to be a reliable analytical method to determine the relationship between environmental lead concentrations and blood lead concentrations for EPA lead rulemaking". The EPA Office of Research and Development has examined several other modeling approaches, including a lead soil matrix model proposed by the Society for Environmental Geochemistry and Health (SEGH) Task Force on Lead in Soil, and has indicated that the favored approach is the Biokinetic Model. Two recent technical support documents have been issued which present the rationale for this modeling approach for developing health criteria for lead (USEPA 1989b, USEPA 1989c). The Biokinetic Model provides a means for incorporating either site-specific or internationally consistent default assumption values regarding exposure scenarios and absorption efficiencies for lead uptake from various media into the exposure analysis to yield estimates of the relative contributions of air, dietary and soil lead to the total estimated lead uptake.

When site-specific data collected in Granite City and soil lead/dust lead levels of 500 ppm and 1,000 ppm were input into the Lead Uptake/Biokinetic Model, the graphs presented in Figures 1 and 2 were obtained. Figure 1 uses the 500 ppm soil lead/dust lead level, soil ingestion rates of 0.100 grams per day as suggested by O'Brien & Gere rather than the default Calabrese data, air lead levels taken from the Remedial Investigation Report, and default values as listed from the Users Guide for Lead: A PC Software Application of the Uptake/Biokinetic Model. No pica was considered; lead in paint was considered not to be available for ingestion (painted surfaces in good condition). An U.S. average water lead level was included to account f.. the contribution from lead in plumbing. The model predicted the mean blood lead level for children under the age of six to be 8.37 micrograms per deciliter, with approximately 8.5 percent of the children predicted to attain blood lead levels greater than 15 micrograms per deciliter. When a soil lead/dust lead level of 1,000 ppm was substituted into the model, approximately 34 percent of the children were predicted to have blood lead levels greater than 15 micrograms per deciliter. This would put 34% of the Granite City children above a level which may represent a risk of adverse health effects. It is notable that the model shows that for most ages, the soil/dust lead intake is greater than 29 micrograms per day while the lead intakes from air and water are nonsignificant. The model also shows that the 500 ppm soil clean-up level appears to be appropriate because further reductions in food lead levels are anticipated due to the removal of lead-containing soils, to education of residents on ways to reduce lead inta' in children provided by the U.S. EPA and IEPA, and to the possible impact o reductions in allowable releases of lead to the air and in the water expected from changes to the National Ambient Air Quality Standard and the National Primary Drinking Water Regulations later this year.

In conclusion, EPA Region V has set a 500 ppm lead soil clean-up level at the NL/Taracorp Superfund site. It ii the best professional judgement of the staff that this level represents the minimun soil clean-up level which can be expected to protect the most sensitive Granite City residents, children under the age of six years.

REFERENCES

ATSDR, The Nature and Extent of Lead Poisoning in Children in the United States: a Report to Congress, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta, GA, 1988.

Binder, S., D. Sokal and D. Maugham, Estimating soil ingestion: the use of tracer elements in estimating the amount of soil ingestion by young children, Arch. Environ. Health, 41: 341-345 (1986).

Calabrese, E.J., H. Pastides, R. Barnes, et al., How much soil do young children ingest: an epidemiological study, Reg. Toxical. Pharmacol., (1989)

FR 50, Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures, Federal Register 50; 1170-1178, Wednesday, January 9, 1985.

Mielke, H.W., J.L. Adams, P.L. Reagan, and P.W. Mielke, Jr., Soil-dust lead and childhood lead exposure as a function of city size and community traffic flow: the case for lead abatement in Minnesota, In B.E. Davies and B>G> Wixson, eds., Lead in Soil: Issues and Guidelines, Supplement to Environmental Geochemistry and Health, Supplement to Volume 9, 253-268 (1989).

Milar, C. and P. Mushak, "Lead contaminated housedust; hazard, measurement and decontamination", in J. Chisolm and D. O'Hara, eds., Lead Absorption in Children, Urban and Schwarzenberg, Baltimore, MD, 1982, pp 143-152.

Needleman, H.L., The persistent threat of lead: medical and sociological issues, Curr. Probl. Pediatr. 18: 697-744 (1988).

OLSC (Ontario Lead in Soil Committee), Review and Recommendations on a Lead in Soil Guideline, Report to the Ontario Minister of the Environment, ISBN 0-7729-2715-4, Hazardous Contaminants Branch, May 1987.

Remedial Investigation Report, Granite City Site, Granite City, Illinois, prepared by O'Brien & Gere Engineers, Inc., Syracuse, NY, September 1988.

Shellshear, I., L. Jordan, D. Hogan and F. Shannon, Environ-mental lead exposure in Christchurch children: soil lead as a potential hazard, New Zealand Med. J., 81: 382-386 (1975).

Steele, M.J., B.D. Beck and B.L. Murphy, Assessing the contribution from lead in mining wastes to blood lead, Gradient Corporation, Cambridge, MA, prepublication copy, 1989.

USEPA 1986a, Air Quality Criteria for Lead, EPA-600/8-83/028aF-dF, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1986.

USEPA 1989a, Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation, Final Draft. Office of Air

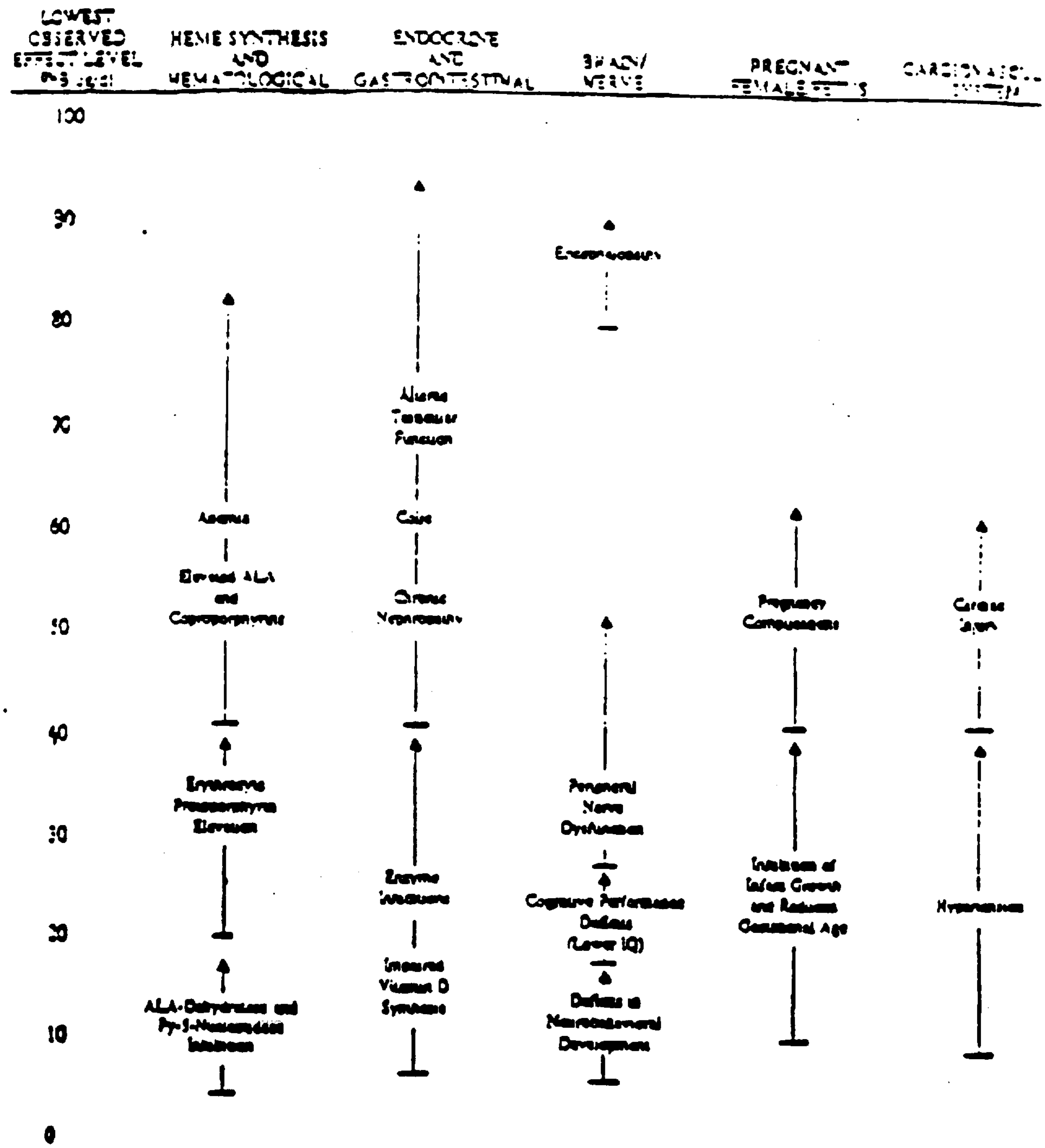
Quality Planning and Standards, Air Quality Management Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1989.

USEPA 1989b, Technical Support Document on Lead, ECAO-CIN-G7, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Cincinnati, OH, 1989.

USDHHS, Preventing Lead Poisoning in Young Children, U.S. Department of Health and Human Services (Centers for Disease Control), January 1985.

TABLE :

Summary of Lowest Observed Effect Levels For Lead-induced Health Effects in Children and Adults



Adapted from U.S. EPA (1986a) with modifications according to ATSDR (1988a)

TABLE 2

SUMMARY OF RECENT STUDIES ON THE ASSOCIATION OF PRENATAL LEAD EXPOSURE WITH SELECTED FETAL OUTCOMES(1)

Reference	N	PbB Source	PbB Average µg/dl	Gestational Age	Birth Weight
Ernhart et al. (1985a, 1986)	185 162	maternal del. cord	6.5 5.8	0 0	0 0
Bellinger et al. (1984)	[illegible]	cord	6.5	+	0[a]
Needleman et al. (1984)	4354	cord	6.5	0	0
Bornschein et al. (1989)	[illegible]	[illegible]	7.0	0	-[a]
Dietrich et al. (1989)	185	maternal pre	8.2	-*	-*
Wolf et al. (1987)	182	infant post-natal	10.1		-*
McMichael et al. (1986)	749	maternal del. cord	11.3 10.1	-* -*	+ +
Moore et al. (1982)	236	maternal del. cord	14.0 g.m. 12.0 g.m.	-* -*	0 0
Rothenberg et al. (1989)	51	maternal pre maternal/del cord	15.6 15.4 13.8	0	-*
Graziano et al. (1989)	907 639	maternal (prospect.) maternal (retrosp.)	17.1 g.m. 15.9 g.m.	0[b]	0
Ward et al. (1987)	100	placental Pb	2.35 µg/g	-	-*

Symbols: 0, no evident relationship; +, positive relationship; -, negative relationship; *, statistically significant at $p<0.05$; g.m., geometric mean.

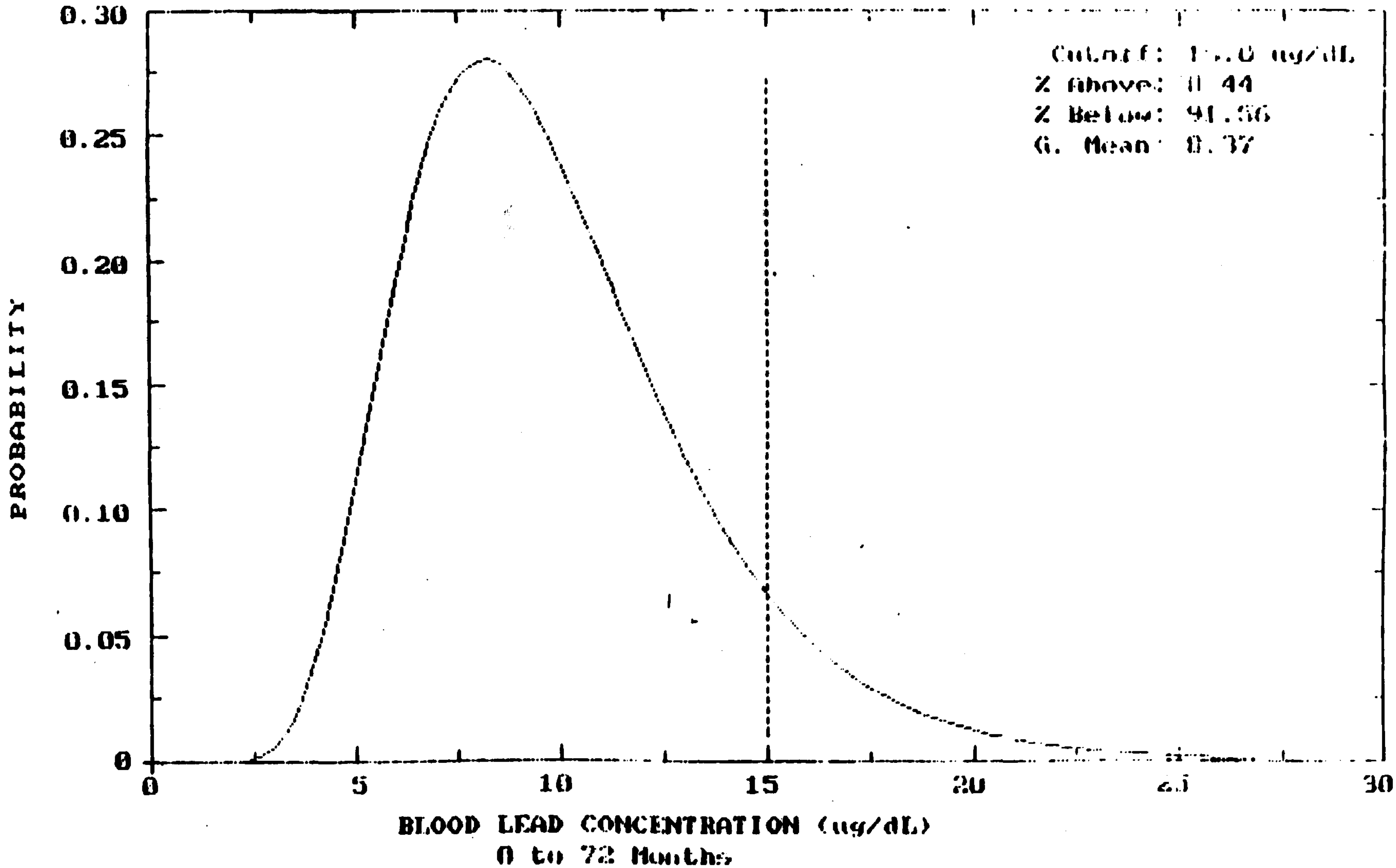
[a]Birth weight showed no relationship, but the trend in percentage of small-for-gestational-age infants was nearly statistically significant at $p<0.05$.

[b]Rate of spontaneous abortions.

(1)From: U.S. EPA 1989a.

Figure 1

Integrated Uptake/Biokinetic Model (500 ppm soil/dust Pb + NL/Taracorp site-specific data)



Air Concentration: 0.260 ug/m3

Diet: DEFAULT

Drinking Water: 8.88 ug/L DEFAULT

Soil & House Dust: Values entered by user.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	500.0	500.0
1-2	500.0	500.0
2-3	500.0	500.0
3-4	500.0	500.0
4-5	500.0	500.0
5-6	500.0	500.0
6-7	500.0	500.0

Additional Dust Sources: None DEFAULT

Paint Intake: 0.00 ug/day DEFAULT

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	5.13	15.73	3.75
1-2:	7.50	30.42	14.99
2-3:	8.78	32.04	14.99
3-4:	9.22	32.24	14.98
4-5:	9.66	32.54	14.97
5-6:	9.83	33.57	14.96
6-7:	10.01	35.08	14.95

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/)
0.5-1:	10.93	0.89	0.00	0.16
1-2:	12.96	2.22	0.00	0.25
2-3:	14.33	2.31	0.00	0.41
3-4:	14.49	2.35	0.00	0.41
4-5:	14.71	2.44	0.00	0.41
5-6:	15.45	2.58	0.00	0.57
6-7:	16.94	2.62	0.00	0.57

A saved ...
LOAD function.

9. VALUES of DEFAULT PARAMETERS

The values of the default parameters which can be changed by the user are as follows:

Air Data:
Air Concentration: 0.20 μg Pb/m³
Lung Absorption: 31.5%
Vary Air Conc by Year: NO
Ventilation Rate

Age	Ventilation Rate
0-1:	2.0 m³/day
1-2:	3.0 m³/day
2-3:	5.0 m³/day
3-4:	5.0 m³/day
4-5:	5.0 m³/day
5-6:	7.0 m³/day
6-7:	7.0 m³/day

Water Data:
Water Concentration: 8.88 μg/ℓ
Use Alternate Values: NO
Water Consumption

Age	Water Consumption
0-1:	0.20 ℓ/day
1-2:	0.50 ℓ/day
2-3:	0.52 ℓ/day
3-4:	0.53 ℓ/day
4-5:	0.55 ℓ/day
5-6:	0.58 ℓ/day
6-7:	0.59 ℓ/day

Diet Data:
Use Alternate Values: NO
Diet Intake

Age	Diet Intake
0-1:	21.86 μg Pb/day
1-2:	25.94 μg Pb/day
2-3:	28.71 μg Pb/day
3-4:	29.05 μg Pb/day
4-5:	29.53 μg Pb/day
5-6:	31.10 μg Pb/day
6-7:	34.26 μg Pb/day

Soil & Dust Data:
[illegible]
Use Alternate Dust Values: NO
Amount Ingested Daily

Age	Amount Ingested Daily
0-1:	0.005 g/day
1-2:	0.050 g/day
2-3:	0.200 g/day
3-4:	0.200 g/day
4-5:	0.050 g/day
5-6:	0.050 g/day
6-7:	0.050 g/day

$\bar{x}_{0-7}$ = 0.086 g/day

Use: 0.100 g/d age 9mo-7

Paint Data: Amount Ingested Daily: 0.0 μg Pb/day (all ages)

Graph Values:
GSD: 1.42
Cutoff: 10 μg Pb/dℓ